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Designing Flash Card Readiness into Today's Systems

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This application note was created to inform the OEM how to make his system Flash card ready.

A number of requests have come in from customers who are adding PCMCIA slots to their systems and want to include the capability to upgrade to flash cards and Microsoft's Flash File System (FFS). This summary discusses how to include flash card upgradability in systems being designed today.

This guide is divided into four areas: standards, hardware, software, and upgrades.

1.0 STANDARDS

PCMCIA revision 2.0 sets the standard for the physical and electrical characteristics of memory and I/O PC cards. Unfortunately, what it doesn't do is set the standard for the host system's architecture. That's where the ExCA™ (Exchangable Card Architecture) specification comes in. ExCA specifies the minimum requirements for what the host system must provide. The ExCA specification covers both the hardware and software requirements of the system. The recommendations in this design guide follow the ExCA requirements.

2.0 HARDWARE

While software can be upgraded at a later date, either in the factory, or in the field, hardware typically cannot. That's why it's so important that all of the hardware necessary to support flash cards be designed into a system up front.

Fortunately, ExCA compliant hardware is available today. The Intel 82365SL PC Card Interface Controller (PCIC) is ExCA compliant and has rapidly become the PC Card controller standard.

The PCIC interfaces the ISA bus to the PCMCIA socket, and handles interrupt steering, memory and I/O window mapping, and power management. A schematic for creating two fully buffered sockets is found in the 82365SL™ datasheet and is included here as Figure 1.(1)

Writing and erasing Flash cards requires $V_{pp} = 12V$, with $I_{pp} = 60\text{ mA}$ minimum. Remember, when choosing a voltage converter, other devices (video, etc) may also require 12V, so take care to pick one that will supply all of your simultaneous needs. For more information and numerous examples on power conversion read Application Note 357 Power Supply Solutions for Flash Memory.

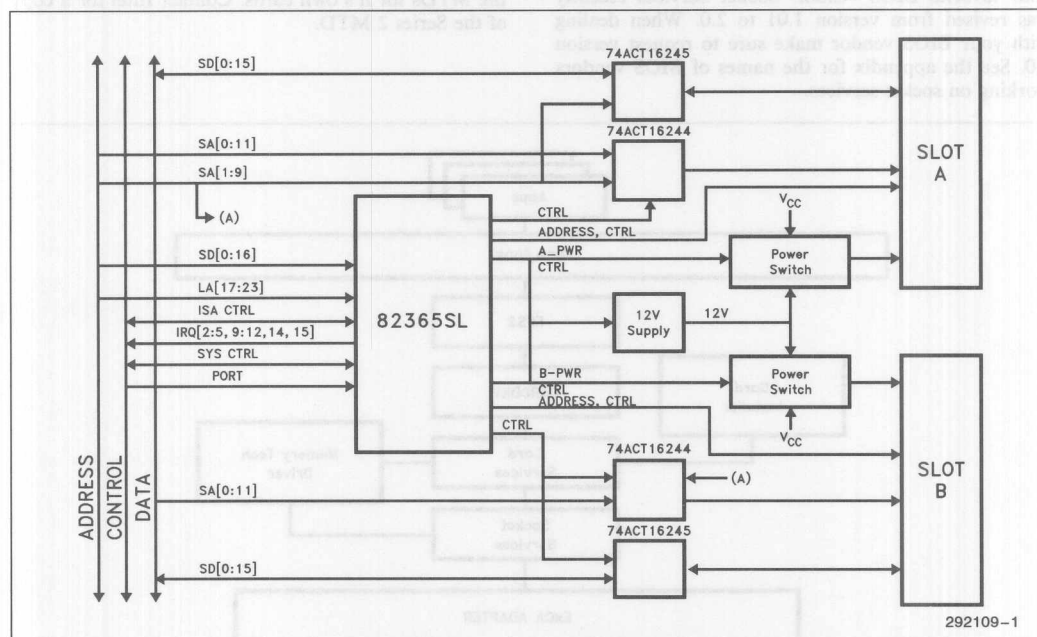


Figure 1. A Buffered, Two-Socket Implementation of the 82365SL

NOTE:

1. Some designers may want to simplify this interface. Note that the buffers allow a user to remove either card without glitching any signals on the system bus.

Many of the future pieces of software that you will want to upgrade your system with are expected to reside in BIOS. Starting with the power-managed notebook and the complex high end desktop class of systems, upgradable flash BIOS has become a common design practice. Leaving sufficient headroom to handle additional code has also become prevalent. Using a 2 MB flash chip as the BIOS storage media should provide sufficient room for most software upgrades.

3.0 SOFTWARE

While ExCA hardware is available today, the full ExCA software hierarchy is still in development. Systems that exist today are not fully ExCA compliant. The problem is much of the software is still being created or is in alpha and beta testing. Figure 2 shows the ExCA software hierarchy.

A brief introduction to the software layers:

Socket Services: The only hardware specific (with the exception of the MTD) piece of software. Socket Services can be loaded as a device driver but eventually will be integrated into the BIOS. All other pieces of software work through Socket Services to communicate with the hardware. Socket Services is available from your favorite BIOS vendor. Socket Services recently was revised from version 1.01 to 2.0. When dealing with your BIOS vendor make sure to request version 2.0. See the appendix for the names of BIOS vendors working on socket services.

Card Services: This is the resource manager of the PC Card system. All drivers notify Card Services upon being loaded. Card Services allocates the system resources as required by both the PC Cards and their respective software drivers. Initially this will be a device driver but is expected to also migrate to the BIOS. The first Card Services should be available from BIOS vendors starting in early Q4'92. When discussing Card Services with your BIOS vendor make a point of letting them know which version of Socket Services you are planning to use.

Memory Technology Driver (MTD): While Carddrv has the ability to program SRAM and bulk erase (Intel Series 1) cards, it does not have the ability to program Series 2 flash cards or to take advantage of the special performance and power management registers on the newer cards. Memory card specific programming algorithms and information on the use of special card features reside inside the MTD. When future cards are released different programming algorithms may be required. By maintaining the memory card specific information as a separate device driver, a system can be upgraded on the fly, with an MTD that is carried on the new card or with an accompanying floppy disk. These new MTD's can be appended to the host's MTD. The first MTD should be available near the end of 1992. Since MTD's are card specific, Intel will provide the MTDs for its own cards. Contact Intel for a copy of the Series 2 MTD.

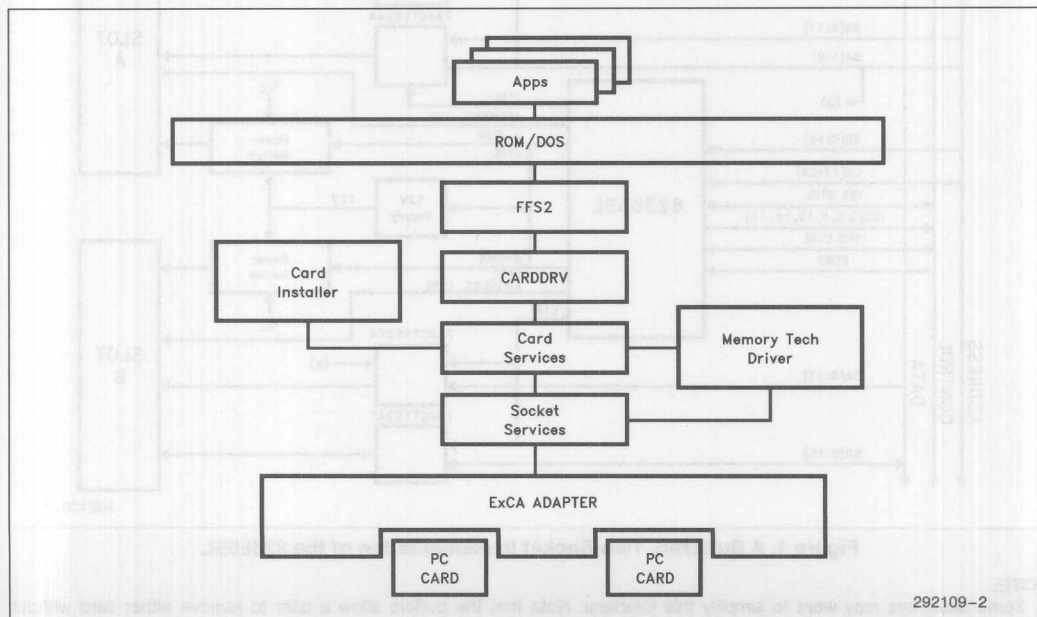


Figure 2. ExCA Software Hierarchy

Card Install: Card Install is a device driver that does for I/O cards much of what MTD does for memory cards. The Card Install software reads a PC Card's attribute memory and if it is an I/O card, configures the card and system accordingly. Flash memory does not use the Card Install software.

FFS2: Microsoft's Flash File System (also called MS-Flash.Sys): FFS2 acts as a redirector by capturing the DOS Int 21h and routing it to the Carddrv software. FFS2 provides the wear-leveling, cleanup algorithms and linked list file structure that maximize the efficiency of flash as a mass storage media.

Carddrv: The interface between FFS2 and the actual ExCA software. Carddrv handles read and write accesses, queuing and erasing blocks in the flash card. Carddrv has the ability to partition cards into more than one type of format. This multi-partitioning gives FFS cards the ability to add a BPB/FAT partition (sometimes called a disk image) and allows bootability. Carddrv has general abilities to write to flash memory, but passes off more card specific requests to the Memory Technology Driver.

Figure 3 shows the main transitional phases of the ExCA software hierarchy. Today, systems that use FFS with Flash cards are running phase 1 software with a customized carddrv that encompasses all of the functions of Socket Services, Card Services, Carddrv, and the MTD. Phase 2 pulls the Socket Services functions out of Carddrv and makes the system software hardware independent. Phase 2 software is just becoming available today. Phase 3 is the first time all of the ExCA software becomes available. Phase 3 is expected to occur late in Q4'92.

Altogether a system will need 50 KB–70 KB of space free for these upgrades. If the OEM stores these features in BIOS he will need at least a 2 MB component.

Due to the recent decision to add compression to their filing system, Microsoft's Flash File System (FFS) production version is not available as of the print deadline of this application note. Though many companies have Beta copies of FFS, it is not expected to go into production until the middle of Q4'92. To get a Beta copy of FFS call Microsoft at the number listed in the Appendix.

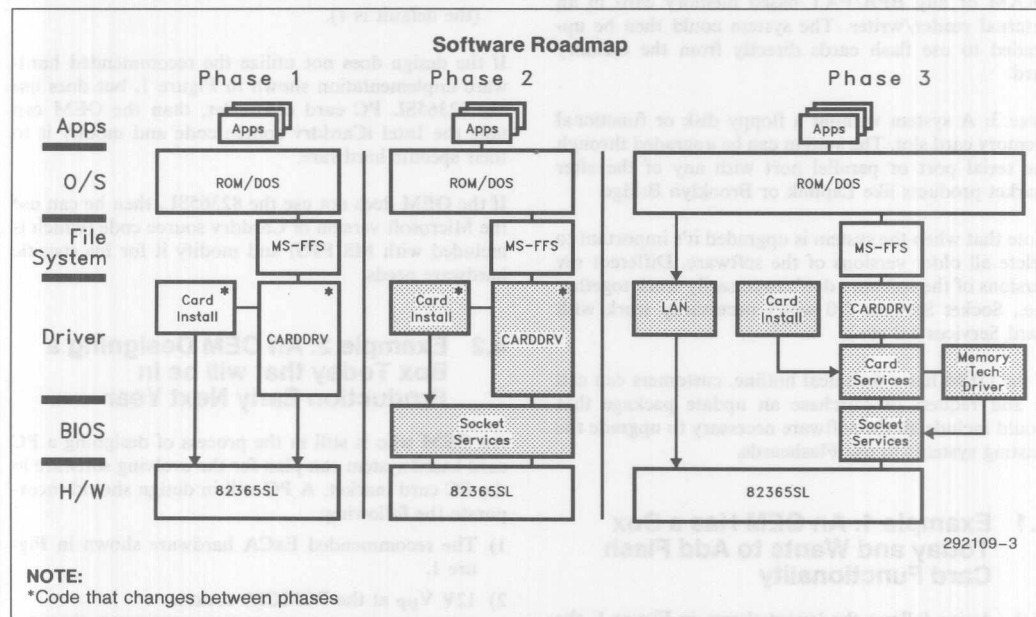


Figure 3. Roadmap of ExCA Software Development

4.0 UPGRADABILITY

By having the hardware designed in up front, a system in the field can be upgraded by simply sending out an upgrade disk. The second half of 1992 will see Card Services, MTD's and Microsoft's Flash File System released. How will existing systems make use of all this new software? Indeed how will they even load it? How do endusers get a hold of this new software?

If the OEM chooses to upgrade the BIOS in purchased systems he will need to include some kind of BIOS upgrade utility (typically available from the BIOS vendors) to either append the new code to the existing BIOS or completely replace the existing BIOS. If the OEM chooses to upgrade systems in the field with device drivers, he can simply send out the code on floppy disks with installation instructions.

Case 1: A system with a floppy disk. The system can be upgraded directly from the diskette.

Case 2: A system without a floppy disk. But with a functional card slot, the software can be copied onto an SRAM or any BPB/FAT based memory card in an external reader/writer. The system could then be upgraded to use flash cards directly from the memory card.

Case 3: A system without a floppy disk or functional memory card slot. The system can be upgraded through the serial port or parallel port with any of the after market products like Laplink or Brooklyn Bridge.

Note that when the system is upgraded it's important to delete all older versions of the software. Different rev versions of the software don't necessarily work together (i.e., Socket Services 2.0 won't necessarily work with Card Services 1.0 etc.).

If the OEM has a technical hotline, customers can call in and request or purchase an update package that would include all the software necessary to upgrade the existing systems to use Flashcards.

4.1 Example 1: An OEM Has a Box Today and Wants to Add Flash Card Functionality

If the design follows the layout shown in Figure 1, the OEM can upgrade his system to flash cards by adding two pieces of software and two lines to his config.sys file.

The first piece of software is Microsoft's Flash File System (MS-FLASH.SYS). The second piece of software is a low level driver called iCARDRV1.EXE and is provided by Intel. iCARDRV1 is a modification of the Microsoft Carddrv program which has been converted to work with the recommended ExCA hardware design.

Load both of these files in a directory and call them from the config.sys file with the following lines:

```
Device=C:\exca\iCardrv1.exe /port=3E0
/base=D0 /slots=2 /part=1
Device = C:\exca\MS-FLASH.SYS
```

The iCarddrv command line options are:

"Port" refers to the I/O address of the 82365SL.

"Base" refers to the starting address of the memory window in system memory. "Base" is a 4K value, so "/base=D0" represents a base address of D0000h.

"Slots" refers to the number of PCMCIA sockets installed on the system.

"Part" refers to the number of partitions in the card (the default is 1).

If the design does not utilize the recommended hardware implementation shown in Figure 1, but does use the 82365SL PC card controller, then the OEM can take the Intel iCarddrv source code and modify it to their specific hardware.

If the OEM does not use the 82365SL, then he can use the Microsoft version of Carddrv source code (which is included with MS FFS) and modify it for his specific hardware needs.

4.2 Example 2: An OEM Designing a Box Today that will be in Production Early Next Year

An OEM who is still in the process of designing a PC card based system can plan for the evolving software in the PC card market. A PC still in design should incorporate the following:

- 1) The recommended ExCA hardware shown in Figure 1.
- 2) 12V V_{pp} at the PCMCIA socket.
- 3) A 2 MB Flash BIOS storage device (to allow for upgrades)
- 4) Microsoft's Flash File System
- 5) Both Socket and Card Services in the BIOS—Contact your favorite BIOS vendor
- 6) iCardrv1 object code from Intel (available in the PC Card Kit, or the ExCA Hardware Developer's Kit)

5.0 CONCLUSION

Software is easily upgradable, hardware is not. While some of the software pieces are still in development, it is still important to design in the hardware pieces today. Having a Vpp capable of supplying 12V, using the 82365SL, and having enough room in the BIOS storage device for the upcoming software will allow a manufacturer to take advantage of today's hardware and tomorrow's software.

Intel's PC Card Kit (order code "PC Card Kit") is the perfect vehicle to assist a card based PC designer. The kit includes the ExCA Developer's Board (block diagram shown in Figure 1), iCardrvl.exe, a 4 MB Series 2 flash memory card, 82365SL diagnostic software, ExCA specification revision 1.1, application notes,

datasheets and a User's Guide showing how to install and run the kit in a desktop. For OEM's who already have Series 2 flash memory cards but still want the ExCA Developer's board and associated documentation there is the ExCA Hardware Evaluation Board (order code "ExCAHEBD"), the contents are the same as the PC Card Kit without the Series 2 card.

If an OEM implements the ExCA hardware design shown in Figure 1, they can *check out the flash functionality of their box today* by using Microsoft's Beta version of FFS (available from Microsoft) in conjunction with a Carddrv that has been specifically modified by Intel to handle all of the Carddrv, Card Services, MTD, and Socket Services functions. This Carddrv is available from Intel by contacting your local sales office.

APPENDIX A

WHERE TO GO FOR MORE INFORMATION:

	Order Number	BIOS vendors working on ExCA Socket Services and Card Services:
imCF004FLSA,010,020 Flash Memory Card Datasheet	#290434	AMI 404-246-8612
82365SL PC Card Interface Controller Datasheet	#290423	Award 408-370-7979
AP-341 Designing an Updatable BIOS	#292077	Phoenix 408-452-6540
		SystemSoft 508-651-0088
		Quadtel 714-754-4422
Implementing the Integrated Regs of Series 2	#292096	Voltage Converters: Maxim, Linear Tech, etc.
28F002BX Datasheet	#290448	Important phone numbers for card based system designers
AP-357 Power Supply Solutions	#292092	PCMCIA 408-720-0107
ExCA Specification	Revision 1.1	ExCA 916-351-2562
PCMCIA Specification	Revision 2.0	Microsoft FFS 206-936-9100
PC Card Kit*	PCCARDKIT	
ExCA Hardware Developer's Kit**	EXCAHWEBD	
Microsoft Flash File System	Call Microsoft at 206-936-9100 (USA)	
Connectors:	Foxconn, AMP, DuPont, Molex, ITTCannon, Fujitsu, JAE, DDK, etc.	

NOTES:

*PC CARD KIT—The PC Card Kit contains: 4 MB Series 2 flash card, Carddrv executable code, PCIC diagnostic software, ExCA Developers board, application notes, datasheets, product briefs, ExCA specification, and a kit User's Guide.

**ExCA Hardware Developer's Platform contains: Carddrv executable code, PCIC diagnostic software, ExCA Developers board, application notes, datasheets, product briefs, ExCA specification, and a kit User's Guide.



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